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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
ZALEPA, GEORGE D	

ART UNIT	PAPER NUMBER
2183	

DATE MAILED: 05/09/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/821,431	CYPHER ET AL.	
	Examiner	Art Unit	
	George D. Zalepa	2183	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09 April 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-27* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 7/11/05 2/0/06
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Claims 1-27 have been considered by the examiner.

Papers Submitted

2. It is hereby acknowledged that the following papers have been received and placed of record in the file: Declaration as filed on 9 April 2004. Information disclose statements as filed on 8 February 2005 and 11 July 2005.

Oath/Declaration

3. The oath or declaration is defective. A new oath or declaration in compliance with 37 CFR 1.67(a) identifying this application by application number and filing date is required. See MPEP §§ 602.01 and 602.02.

> The oath or declaration is defective because: City and State of Residence of Stevan Vlaovic is missing.

Specification

4. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: Branch prediction scheme utilizing multiple branch predictors and multiple index hashing mechanisms for determining a final prediction based on intermediaries.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1-8, 12-20, and 25-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Loh (US Pat. Appl. Pub. 2005/0223203; herein referred to as "Loh".) in view of McFarling (US Pat. Appl. Pub. 2001/0056531; herein referred to as "McFarling".).

7. Regarding **independent claim 1**,

8. Loh discloses *a branch prediction mechanism comprising: a first storage including a first plurality of locations for storing a first set of partial prediction information* [see Loh, Fig. 4, element 405 (e.g., "Branch Predictor 1")]*; a second storage including a second plurality of locations for storing a second set of partial prediction information* [see Loh, Fig. 4, element 405 (e.g., "Branch Predictor 2"); Examiner's note: Loh does not limit the invention to a particular type of predictor, however, Loh states that global history could be used to index the predictors, thus it is inherent that global predictors would be utilized as the predictors. An example of a common global predictor is shown in McFarling, Fig. 4. N.B., a global predictor contains an array of saturating counters.]*; wherein said control unit is further configured to provide a prediction value based on corresponding partial prediction information in said selected locations of said first and said second storages* [see Loh, Fig. 4, element 410; Para 0020, lines 3-7; Examiner's note: Since Loh discloses the prediction of segments of a branch history, it is clear that the intermediate predictions are for the segments and thus are only partial predictions, thus the need for a mechanism to determine a final prediction which is disclosed by Loh in element 410 of Figure 4.].

9. Loh does not disclose *performing a first hash function on input branch information to generate a first index for accessing a selected location within said first storage and* performing *a second hash function on said input branch information to generate a second index for accessing a selected location within said second storage.*

10. McFarling does disclose *performing a first hash function on input branch information to generate a first index for accessing a selected location within said first storage and* performing *a second hash function on said input branch information to generate a second index for accessing a selected location*

within said second storage [see McFarling, Para. 0026, lines 10-13; Examiner's note: McFarling discloses utilizing a hashing function to index global predictors.].

11. The advantage of using a hash function to index a global predictor would have been to improve the global prediction accuracy [see McFarling, Para. 0026, lines 13-15]. This advantage is desirable in the environment disclosed by Loh as improving the accuracy of a branch prediction would increase the performance of an entire processor by reducing the amount of mispredictions and in turn fetching errors. This advantage would have motivated one of ordinary skill in the art at the time of invention to utilize a hashing mechanism, as disclosed by McFarling, to index a set of predictors as disclosed by Loh. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to use a hashing mechanism to index a set of predictors with the goal of increasing prediction accuracy.

12. Regarding **claim 2,**

13. Loh discloses the *prediction value* [providing] *a strongly/weakly taken/not taken branch prediction indication that is indicative of whether a current branch instruction is taken upon execution* [see Loh, Para. 0020, lines 3-7; Examiner's note: Loh discloses a final prediction being a function of the partial predictions, if said partial predictions are based on a commonly used n-bit saturating counter (commonly known at the time of invention), it is inherent that the final prediction based on said partial predictions would have been of the same format.].

14. Regarding **claim 3,**

15. Loh discloses *said input branch information* [including] *branch history information corresponding to an outcome of a number of preceding branch instructions* [see Loh, Para. 0021].

16. Regarding **claim 4,**

17. Loh discloses *said first hash function and said second hash function...configured to operate on a portion of said branch history information* [see Loh, Para. 0018, lines 9-11].

18. Regarding **claim 5,**

19. McFarling discloses *said input branch information* [including] *address information corresponding to a fetch address of a current branch instruction* [see McFarling, Fig. 5, element 50; Para. 0026, lines 10-13 "...the branch instruction address...".].

20. The advantage of using the current fetch address would have been to fully realize the hashing function disclosed by McFarling (see rejection for Claim 1 of this action). McFarling states that by hashing the address and branch history and using the result as an index to a branch predictor would have increased the accuracy of the predictor, thus it would have been obvious to one of ordinary skill in the art at the time of invention to utilize the address and branch history when address the predictors. Applicant is referred to the rejection of claim 1 for additional reasoning.

21. Regarding **claim 6,**

22. Loh discloses *said first hash function and said second hash function...configured to operate on a portion of said fetch address* [see Loh, Para. 0018, lines 9-11].

23. Regarding **claim 7,**

24. Loh discloses *each of said first and said second sets of partial prediction information* [including] *a plurality of counter values each corresponding to a strongly/weakly taken/not taken branch prediction indication that is indicative of whether a current branch instruction is taken upon execution* [see Loh, Para. 0020, lines 3-7; Examiner's note: Loh discloses a final prediction being a function of the partial predictions, if said partial predictions are based on a commonly used n-bit saturating counter (commonly known at the time of invention), it is inherent that the final prediction based on said partial predictions would have been of the same format.].

25. Regarding **claim 8,**

26. Loh and McFarling do not explicitly disclose the *control unit* [being] *further configured to use said prediction value to determine whether a current branch instruction is taken upon execution, wherein*

said prediction value is generated by summing respective counter values stored within said selected location within said first storage and said selected location within said second storage.

27. However, Loh discloses using multiple values of saturating counters (typically ranging between the value of 0-3 as common at the time) and performing an action on said counters to derive a final prediction. At the time of invention it would have been obvious that an addition or average (inherently containing addition) of the partial counter values would have resulted in the best prediction with the least amount of overhead.

28. Regarding **claim 12**,

29. McFarling discloses a *control unit...further configured to update said selected locations of said first and said second storages dependent on whether said prediction value yields an accurate branch prediction* [see McFarling, Para. 0021, lines 6-9; Examiner's note: McFarling discloses tracking branch instructions which would involve updating the counters in a branch predictor. Furthermore, the primary goal of a branch predictor employing saturating counters, such as the well known counters proposed by Lee and Smith, would have been to update said counters based on branch execution.].

30. Regarding **claim 13**,

31. Loh discloses *a third storage including a third plurality of locations for storing a third set of partial prediction information and wherein said control unit is further configured to perform a third hash function on input branch information to generate a third index for accessing a selected location within said third storage* [see Loh, Fig. 4, element 405 (e.g., "Branch Predictor *k*"); Examiner's note: Loh does not place a limit on how many intermediate predictors are possible in the invention.].

32. Regarding **claim 27**,

33. Loh discloses *a branch prediction mechanism comprising: means for storing a first set of partial prediction information within a first storage including a first plurality of locations* [see Loh, Fig. 4, element 405 (e.g., "Branch Predictor 1")]*; means for storing a second set of partial prediction*

information within a second storage including a second plurality of locations [see Loh, Fig. 4, element 405 (e.g., "Branch Predictor 2"); Examiner's note: Loh does not limit the invention to a particular type of predictor, however, Loh states that global history could be used to index the predictors, thus it is inherent that global predictors would be utilized as the predictors. An example of a common global predictor is shown in McFarling, Fig. 4. N.B., a global predictor contains an array of saturating counters.]*; and means for providing a prediction value based on corresponding partial prediction information in said selected locations of said first and said second storages* [see Loh, Fig. 4, element 410; Para 0020, lines 3-7; Examiner's note: Since Loh discloses the prediction of segments of a branch history, it is clear that the intermediate predictions are for the segments and thus are only partial predictions, thus the need for a mechanism to determine a final prediction which is disclosed by Loh in element 410 of Figure 4.].

34. Loh does not disclose a *means for performing a first hash function on input branch information to generate a first index for accessing a selected location within said first storage and performing a second hash function on said input branch information to generate a second index for accessing a selected location within said second storage.*

35. McFarling does disclose a *means for performing a first hash function on input branch information to generate a first index for accessing a selected location within said first storage and performing a second hash function on said input branch information to generate a second index for accessing a selected location within said second storage* [see McFarling, Para. 0026, lines 10-13; Examiner's note: McFarling discloses utilizing a hashing function to index global predictors.].

36. The advantage of using a hash function to index a global predictor would have been to improve the global prediction accuracy [see McFarling, Para. 0026, lines 13-15]. This advantage is desirable in the environment disclosed by Loh as improving the accuracy of a branch prediction would increase the performance of an entire processor by reducing the amount of mispredictions and in turn fetching errors. This advantage would have motivated one of ordinary skill in the art at the time of invention to utilize a

hashing mechanism, as disclosed by McFarling, to index a set of predictors as disclosed by Loh. Therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to use a hashing mechanism to index a set of predictors with the goal of increasing prediction accuracy.

37. Regarding **claims 14-21, 25-26,**

38. **Claims 14-21, 25-26** are rejected as being the method performed by the apparatus in **claims 1-8, 13-14**, respectively.

39. Claims 9-11 and 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Loh in view of McFarling, further in view of Yeh et al. (US Pat. No. 6,427,206; herein referred to as "Yeh".).

40. Regarding **claim 10,**

41. Loh and McFarling disclose the limitations as stated in **independent claim 1**.

42. Loh and McFarling do not disclose *the control unit is further* [being] *configured to use said prediction value to control whether a branch prediction is performed in accordance with a branch prediction hint encoded within a current branch instruction.*

43. Yeh does disclose *the control unit is further* [being] *configured to use said prediction value to control whether a branch prediction is performed in accordance with a branch prediction hint encoded within a current branch instruction* [see Yeh, Col. 6, lines 18-35; Examiner's note: Yeh discloses the use of a prediction "hint" (Col. 2, lines 62-64) encoded into the instruction by the compiler. This hint is utilized in conjunction with a branch prediction scheme (Col. 6, lines 18-35) to determine the appropriate branching behavior.].

44. The advantage of utilizing a hint bit in conjunction with a branch prediction scheme would have been to determine in advance how certain a processor will be on the taken/not-taken tendencies of a branch instruction prior to its execution based on profiling the instruction by a compiler (Col. 2, lines 5-7). This advantage would have been desirable in the invention of Loh and McFarling as it would have sped up execution for branches that have been profiled correctly as strongly taken or strongly not-taken.

Furthermore, as admitted by the applicant, modern processors are known to support a hint bit encoded by the compiler, therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to account for the hint bit in modern processors in the invention of Loh and McFarling. This advantage would have motivated one of ordinary skill in the art at the time of invention to account for the prediction hint and allow a branch prediction unit to use the hint to its advantage in determining the correct path of a branch.

45. Regarding **claim 9**,

46. Loh, McFarling and Yeh disclose the limitations as stated in **claim 9**.

47. Yeh further discloses *each of said first and said second sets of partial prediction information* [including] *a plurality of counter values each corresponding to a strongly/weakly agree/disagree indication that is indicative of whether said branch prediction hint bit embedded within said current branch instruction is to be used by said control unit* [see Yeh, Col. 6, lines 18-35; Examiner's note: Yeh discloses using a hardware branch predictor if confidence in the compiler hint is not strong, that is, if the compiler is below a threshold of assuredness a branch prediction is further utilized to determine whether the hint bit is correct (e.g., hint = taken, predictor = strongly taken) or if the bit is incorrect (e.g., hint = taken, predictor = strongly not-taken).].

48. The advantage of utilizing a hint bit in conjunction with a branch prediction scheme would have been to determine in advance how certain a processor will be on the taken/not-taken tendencies of a branch instruction prior to its execution based on profiling the instruction by a compiler (Col. 2, lines 5-7). This advantage would have been desirable in the invention of Loh and McFarling as it would have sped up execution for branches that have been profiled correctly as strongly taken or strongly not-taken. Furthermore, as admitted by the applicant, modern processors are known to support a hint bit encoded by the compiler, therefore, it would have been obvious to one of ordinary skill in the art at the time of invention to account for the hint bit in modern processors in the invention of Loh and McFarling. This

advantage would have motivated one of ordinary skill in the art at the time of invention to account for the prediction hint and allow a branch prediction unit to use the hint to its advantage in determining the correct path of a branch.

49. Regarding **claim 11**,

50. Loh, McFarling, and Yeh disclose the limitations as stated in **claim 10**.

51. Loh, McFarling, and Yeh do not explicitly disclose *the prediction value* [being] *generated by summing respective counter values stored within said selected location within said first storage and said selected location within said second storage.*

52. However, Loh discloses using multiple values of saturating counters (typically ranging between the value of 0-3 as common at the time) and performing an action on said counters to derive a final prediction. At the time of invention it would have been obvious that an addition or average (inherently containing addition) of the partial counter values would have resulted in the best prediction with the least amount of overhead.

Conclusion

53. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US Patent 6,754,813 to Nakada discloses the use of a prediction hint in conjunction with a branch prediction unit.

US Pat. Appl. Pub. 2005/0149707 to Jourdan et al. discloses utilizing parallel global predictors.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to George D. Zalepa whose telephone number is (571) 272-6754. The examiner can normally be reached on Monday-Friday (alt. Friday off).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie P. Chan can be reached on (571) 272-4162. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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